2025 年度シラバス

科目分類/Subject Categories			
学部等/Faculty	/大学院工芸科学研究科（博士前期課程）：/Graduate School of Science and Technology (Master's Programs)	今年度開講/Availability	/有 ：/Available
学域等/Field	/物質・材料科学域 ：/Academic Field of Materials Science	年次/Year	/１～２年次 ：/1st through 2nd Year
課程等/Program	/機能物質化学専攻 ：/Master's Program of Functional Chemistry	学期/Semester	/通年 ：/All year (Spring/Fall)
分類/Category	/授業科目 ：/Courses	曜日時限/Day & Period	/ : /

科目情報/Course Information				
時間割番号 /Timetable Number				
科目番号 /Course Number	61960025			
単位数/Credits	2			
授業形態 /Course Type	講義 ：Lecture			
クラス/Class				
授業科目名 /Course Title	Mathematical Methods for Physics : Mathematical Methods for Physics			
担当教員名 / Instructor(s)	/機能物質化学専攻関係教員 ：Related teacher of the Master's Program of Functional Chemistry			
その他/Other	インターンシップ実施科目 Internship	国際科学技術コース提供科目 IGP	PBL 実施科目 Project Based Learning	DX 活用科目 ICT Usage in Learning
	実務経験のある教員による科目 Practical Teacher			
科目ナンバリング /Numbering Code				

授業の目的・概要 Objectives and Outline of the Course	
日	
英	This course is offered during the first semester of the first year, so it is the first course that all students will be exposed to upon their entrance into the Master program in Science and Technology of Bio and Nanomaterials. As the background of the incoming students may (and indeed is) diverse, this course is designed to provide the advanced mathematical skills that will enable all students to tackle more advanced courses of the first and second years. While is not a corse (i.e. required) course, it will be strongly recommended to all students whose original degree did not provide a sufficient mathematical background. Particular emphasis will be devoted to problem solving techniques of Quantum Mechanics, as for instance partial differential equations, eigenvalues and eigenfunctions, perturbation theory, and algebra of commutators, rather than to formal methods.

学習の到達目標 Learning Objectives	
日	
英	Single out the main points of a complex problem Decompose it into simpler sub-problems that can be more conveniently solved Perform non-trivial calculations on their own Identify the correct technique to be used to solve a physics problem Solve the most common ordinary and partial differential equations in the physical sciences Use Fourier transforms

	Compute eigenvalues and eigenvectors

学習目標の達成度の評価基準 / Fulfillment of Course Goals（JABEE 関連科目のみ）	
日	
英	

授業計画項目 Course Plan			
No.		項目 Topics	内容 Content
1	日		
	英	INTRODUCTIONS	Taylor's series, Planar polar coordinates, Complex numbers, Chain rule in differentiation, Hyperbolic functions
2	日		
	英	ORDINARY DIFFERENTIAL EQUATIONS (1)	General definitions and simple concepts, 1st order, 1st degree differential equations , Separation of variables, Exact differential equations,
3	日		
	英	ORDINARY DIFFERENTIAL EQUATIONS (2)	Linear 1st order differential equations, Bernoulli equation, Higher order differential equations homogeneous and with constant coefficients, Particular solution evaluation
4	日		
	英	FOURIER ANALYSIS AND DIRAC δ-FUNCTION (1)	Basic idea of the Fourier expansion, Fourier series, Conjugate variables, Advantages, uses of Fourier series, Complex form, Fourier transform, Dirac δ-function and representations, Proprieties of the Dirac δ-function.
5	日		
	英	FOURIER ANALYSIS AND DIRAC δ-FUNCTION (2)	FOURIER ANALYSIS AND DIRAC δ-FUNCTION (2)
6	日		
	英	FOURIER ANALYSIS AND DIRAC δ-FUNCTION (3)	Fourier transform of a derivative, Fourier transform of a real function, Gaussian integrals, Fourier transform of a Gaussian, Solution of diffusion equation.
7	日		
	英	VECTOR ANALYSIS	Basic concepts in Matrices, Orthogonal transformations, Scalar, vector and tensor fields, Differential operators, Gauss theorem and divergence, Stokes theorem and Curl
8	日		
	英	VECTOR SPACES (1)	Linear independence and basis, Linear transformations, Inverse linear transformations and existence conditions.
9	日		
	英	VECTOR SPACES (2)	Matrix representation with respect to a basis, Special classes of matrices, Determinant and relative properties, Similarity transformations.
10	日		
	英	VECTOR SPACES (3)	System of linear equations, Eigenvalue problem, Examples of eigenvalues and eigenvectors, Normal modes of a triatomic molecule.
11	日		
	英	HILBERT SPACES (1)	Scalar product and pre-Hilbert spaces, Hilbert spaces, Hermitian operators, Unitary operators, Dirac ket-bra formalism, {X} e {P} representations and L2 Hilbert space,
12	日		
	英	HILBERT SPACES (2)	Commutators and uncertainty principle, Functions of operators and commutator algebra, Translation operator T
13	日		
	英	Additional topics (1)	GREEN FUNCTIONS AND INTEGRAL EQUATIONS
14	日		
	英	Additional topics (2)	CALCULUS OF VARIATIONS
15	日		
	英	Oral exam	Oral examination on the above topics

履修条件 Prerequisite(s)	
日	
英	

授業時間外学習（予習・復習等） Required study time, Preparation and review	
日	
英	The course is designed to be as self-consistent as possible. A standard Calculus course covering up to partial derivatives, integrals and series of functions is required. Useful, but not necessary, are the knowledge of introductory physics concepts in mechanics and electromagnetism, at the same level of those offered at any first level BS degree. It is strongly encouraged the attendance to the preliminary course "Principles of Mathematics" https://www.unive.it/data/insegnamento/332894 that was designed to bring all students to the appropriate entry level.

教科書／参考書 Textbooks/Reference Books	
日	
英	Suggested reading G. B. Arfken and H.Weber Mathematical Methods for Physicists (Elsevier 2005) [BAS] D. McQuarrie Mathematical Methods for Scientists and Engineering (University Science Books 2003) [BAS]

成績評価の方法及び基準 Grading Policy	
日	
英	Written and oral exams Detailed description of the assessment methods Final grade will be the average of an oral exam (worth 50% of the final grade) and of the average grade reported on homeworks that will be assigned during the semester (and worth the

留意事項等 Point to consider	
日	
英	